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ABSTRACT

To evaluate and document the effectiveness of miner training, a study monitored a wide variety of classroom sessions conducted for new miner and annual refresher training. Seven trainers and 275 mine trainees at fourteen sites in Kentucky, Maryland, Pennsylvania, and West Virginia participated. Observations were made of classes in underground new miner and annual refresher training and in surface annual refresher training. Course materials were both instructional modules developed by the Bureau of Mines and instructor materials. Field data collection involved audiotaping of classroom sessions, pre- and post-testing of trainees, and interviews with students and instructors. Test scores alone showed significant gains. A one-way analysis of variance was performed on variables identified by expert opinion. As regards underground inexperienced training, results indicated that training eliminated educational differences seen in pretest analysis and type of training (company, freelance, vocational-technical, extension) was significant for both pre- and post-test. As regards annual refresher training, results indicated any previous training was a significant variable for pretest scores and years of mining experience were not significant. Measurement techniques frequently used in classic classroom investigations were found inappropriate for evaluating mine training, since miners had no motivation to perform well on tests. (YLB)

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An Overview of Miner Training: RECOMMENDATIONS FOR CURRICULUM DEVELOPMENT, INSTRUCTIONAL STRATEGIES, AND EVALUATION TECHNIQUES FOR CLASSROOM TRAINING

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An Overview of Miner Training: RECOMMENDATIONS FOR CURRICULUM DEVELOPMENT, INSTRUCTIONAL STRATEGIES, AND EVALUATION TECHNIQUES FOR CLASSROOM TRAINING

ABSTRACT

The federal government has outlined in the Federal Mine Safety and Health Amendments Act of 1977, specific requirements in terms of hours of instruction as well as topics to be covered in training underground and surface miners. Findings and observations relative to current research in improving the effectiveness of classroom instruction supporting new miner and annual refresher training are highlighted in this paper. Particular emphasis is on curriculum development, instructional strategies, and evaluation techniques that could contribute to the development of more effective mine training programs. Recommendations are made as to the use and limitations of various classroom evaluation techniques and to possible improvements in the design and implementation of classroom training.

INTRODUCTION

The attention given to safety and skills training by members of the mining community has increased greatly over the preceding decade. A sizeable percentage of this increased attention can be attributed to training mandates as outlined in the 1977 Federal Mine Safety and Health Amendments Act. These mandates were subsequently promulgated under The Code of Federal Regulations, Title 30 - Mineral Resources, Part 48 - Training and Retraining.

These mandates did not guarantee success in effecting a reduction of lost-time injuries. Aggregate injury data have provided little evidence of the effectiveness of formalized training. Industry-wide efforts to improve the quality of formalized training (and to reduce accident frequencies) have taken many avenues, including simulated work environments, extensive use of classroom facilities, structural on-the-job training and performance based supervision. If training is to fulfill its potential as a principal contributor to improved work performance, continuous improvements in the quality of training need to be investigated.

Prior to the summer of 1979, no other efforts had been undertaken in observing and evaluating mine training in the classroom until the Bureau of Mines commissioned West Virginia University to evaluate and document the effectiveness of miner training. This paper is concerned with one aspect of miner training - classroom instruction.

The study methodology of this contract included the monitoring of a wide variety of classroom sessions conducted for new miner and annual refresher training. Field data collection involved the audiotaping of the classroom sessions, pre- and posttesting of trainees, and interviews with students and instructors.

Although the sites that were visited did not constitute an extensive representative sample of the industry, the results and findings do provide information as to the identification and documentation of instructional strategies.

STUDY DESIGN

General Method of Study

Participation was voluntary on the part of the providers of the training. Approximately 30 different providers, including coal companies, schools, colleges and universities, and private training companies were contacted. Of these contacts, 15 trainers agreed to participate. Data contained in this report reflect the efforts of 7 different trainers at 14 different sites located in Kentucky, Maryland, Pennsylvania, and West Virginia. Observations were made of classes in underground new miner and annual refresher training, and in surface annual refresher training.

Since mine training is mandated, no control group was available for use. A variation on the single subject design was adapted with the individual miner trainee serving as the experimental unit for analysis. The individual was observed at two or more points in time with some training occuring between observations. Therefore, it was determined that any change in performance would be due to the training method used.

Since it was not possible to exercise rigid experimental control over the study, the observations serve solely as an estimation of the trainee's performance. Among these factors were the trainee's previous experience in the coal industry, friends and relatives working in the industry, and residence in the mining community. In addition, the instructor at each site for each type of training developed his own training agenda. There was no control over the course design or method of delivery. These factors and others contributed to the trainee's performance and are considered in the interpretation of the results.

Specific Method of Study

Course Material

A complete set of instructional modules was made available in draft form to the mining industry. These materials, developed for Mine Safety and Health Administration (MSHA), by the Bureau of Mines, consisted of one module for each prescribed topic outlined in 30CFR, Part 48. These materials served only in part as the course material for this study. The instructors, although all familiar with the MSHA modules, most often preferred to use their own course materials. Many times, the instructor's materials were supplemented by the MSHA materials.

Testing

For each type of training, annual refresher and inexperienced miner, two samples of items to be used as a pretest and posttest were randomly selected from an item pool previously developed for use with the MSHA modules. Additional items were developed for those topics needing additional items. The pretest was administered at the beginning of the training program and the posttest was given at the completion of the program. The difference between the two scores can be said to represent a change in the individual's performance that can be attributed to the training.

Some participants were also administered progress checks during the course of the training. Each progress check relates to a specific objective covered in a module. Performance on the progress check not only served as a measure of the level of mastery of the objectives tested, but also reinforced the course material being presented. The trainer would then review the answers and offer additional instruction on those objectives that proved to be troublesome to the trainees.

Audiotaping

Since the instructor had total command over course design and delivery, it was determined important to monitor the instructor's presentation. Audiotaping was used to document the various training techniques. These tapes were analyzed on the basis of time spent in each subject area and on method of presentation and class participation.

Interviews

Demographic information was also obtained on each miner. Information provided data on important aspects of the training program that could not be measured through the pretests, posttests, progress checks, or audiotaping. These data included trainee reaction to class presentation and suggestions for revision and improvements to the training program. Similar interviews were conducted with the trainers to obtain information on their course design, instructional strategy and personal reactions to the study.

RESULTS AND DISCUSSION

Specific Results and Discussion

A total of 275 mine trainees were involved in this study investigating classroom instruction in miner training. The fourteen sites participating represented a variety of types of training available for the three training programs examined.

The number of trainees at each site for each type of training and for each type of training program is given in Table 1.

TABLE 1

NUMBER OF TRAINEES
BY TYPE OF TRAINING AND
BY TYPE OF PROGRAM

	Type of Program				
Type of Training	Company	Freelance	Vo-Tech	Extension	Total
Underground Inexperienced	9 17	11	25 21	9	92
Underground Annual Refresher	15 9	0	9 23	19 31	106
Surface Annual Refresher	0	0	0	44 33	77
Total	50	11	78	136	275

Company training is given at an individual mining company for its own employees. The trainer is MSHA certified and has often times been promoted to this position from within, usually having had experience in mining rather than

in education or training. The freelance training is a training consultant who travels to various mine sites and provides the necessary training for a fee. Also MSHA certified, these businesses are often state certified as well. The vo-tech programs are part of the public school system. Their trainers are certified by their state as educators and by MSHA as mine trainers. The mining extension programs (or as indicated here simply as extension programs) operate within the structure of a college or university. These instructors, as well as being MSHA certified, are on the parent institution's staff with many extension instructors holding faculty status at the school.

The length of time for each training program varied from 8 hours to 80 hours depending on the requirements of the program and the requirements of the state where the training was being offered.

Table 2 indicates the number of sites and their corresponding hours of instruction by type of training and by type of program.

TABLE 2

HOURS OF INSTRUCTION
BY TYPE OF TRAINING AND
BY TYPE OF PROGRAM

Type of Training	Type of Program			
	Company	Freelance	Vo-Tech	Extension
Underground Inexperienced	(2)* 40	(1) 80	(2) 48	(1) 40
Underground Annual	(2) 8	0	(2) 8	(2) 8
Surface Annual	0	0	0	(2) 8

* Number in parenthesis indicates number of training sites.

The state of West Virginia requires a minimum of 80 hours of training for underground inexperienced miners. Only one site, a freelance program, represents this requirement and is shown in Table 2. Those two sites having 48 hours of underground inexperienced training were from Kentucky where the state requires 48 hours of training. The two company sites providing 40 hours of underground inexperienced training are meeting the federal requirements. The federal requirements for both surface and underground annual refresher training is 8 hours, which all 8 sites for annual refresher training met.

Table 3 shows a summary of pretest and posttest results by site.

TABLE 3

SUMMARY TEST RESULTS
BY SITE

Type of Training	Site	Mean % Pretest	Mean % Posttest
	A	58	85
	B	55	70
Underground	C	56	71
Inexperienced	D	60	90
	E	48	71
	F	33	88
	Overall mean score	52.17	79.17
	G	66	69
	H	48	57
Underground	I	60	67
Annual Refresher	J	68	69
	K	62	74
	L	65	75
	Overall mean score	61.50	68.50
Surface	M	53	79
Annual Refresher	N	54	68
	Overall mean score	53.50	73.50

Scores on the pretest for underground inexperienced miners ranged from 20% to 60% correct, with the overall average being approximately 52% correct. Posttest scores were from 50% to 100% with the average being approximately 79%. Underground annual refresher pretest scores averaged 61% with scores ranging from 24% to 89%. Posttest scores ranged from 19% to 100% with the overall mean score approximately 69%. For the surface annual refresher, the overall average pretest score was 54% with scores from 9% to 86%, and the posttest mean score was 74% with a range from 20% to 100%.

Underground Inexperienced Miner

A one-way analysis of variance (ANOVA) was performed for each of the nine variables that were identified by expert opinion as important research considerations for the underground inexperienced miner training. Scores on the pretest and on the posttest were used as criterion variables.

A summary of these analyses is given in Table 4.

TABLE 4

SUMMARY OF ANOVA
UNDERGROUND INEXPERIENCED TRAINING

	Pretest		Posttest	
Variable	F	p-value	F	p-value
Previous Mining Experience	0.6	.441	3.45	.067
Enrolled in School	8.03	.006	0.80	.372
Job Lined Up	0.02	.877	8.18	.005
Employed Now	1.17	.282	6.89	.010
Trainer Uses Tests	5.26	.024	11.71	.001
Age	1.22	.311	1.49	.166
Level of Schooling	8.19	.000	.60	.662
Type of Training	9.54	.000	6.24	.000
Course Hours	14.03	.000	2.23	.114

Previous mining experience did not appear to have a significant effect on either the pretest ($p = .441$) or the posttest ($p = .067$). For those students currently enrolled in some other type of mine training, such as a mining technician program, their pretest scores were higher than for those not currently enrolled. This difference was not evident on the posttest ($p = .372$), indicating that the training eliminated any difference in the entrance level knowledge of mining. The students who did not have a job waiting for them at the completion of the training program did score higher on the posttest ($p = .005$). Since no significant difference is apparent for the pretest, it can be suggested that those students with no pending employment were motivated to perform better in the training than those having a job waiting for them when they finished the training. Similar results are seen for those trainees who currently did not hold a job (pretest, $p = .282$; posttest, $p = .010$). No significant difference is evident due to age; however, the level of education did effect the pretest ($p = .000$) with those having a more advanced level of education scoring higher on the pretest where mean = 56.24 for those trainees who had at least completed high school and mean = 37.88 for those not completing high school. This is not seen in the posttest analysis ($p = .660$), thereby suggesting that the training eliminates those educational differences seen in the pretest analysis.

The type of training was significant for both the pretest and the posttest with $p = .000$. In subsequent analysis on the pretest scores, the vo-tech training differed significantly from the other types of training, with this group scoring lower than the others. However, in additional analysis on the posttest scores, the extension and freelance training, while not different from each other, did differ significantly from company and vo-tech training, with company and vo-tech scoring lower than the other two types of training.

It could be suggested that the difference seen in the pretest analysis is due to the fact that the vo-tech schools are less discriminate in their selection of trainees than any other type of training. Therefore, these trainees are more heterogeneous than those trainees in any other group. What is important, in comparing the groups on their pretest and posttest scores, is that although the extension, company, and freelance training do not differ at the beginning of the course, there is a significant difference at the completion. The freelance and extension training appeared more effective than the company training.

Although course hours were not significant on the posttest ($p = .114$), there was a significant difference on the pretest ($p = .000$). This difference can be attributed to the population of students that are attracted to the various trainings. For example, the mean score for the 80-hour course was higher than for the other types of training having 48 or 40 course hours. This class was held in West Virginia where it is necessary to have attended a new miner inexperienced class before applying for a job. If a trainee is not hired within a year, it is necessary to retake the course. Therefore, it is hypothesized that this difference is due to the fact that many of the trainees had previously taken the course.

Annual Refresher Training

Because of the small sample size of the groups, the scores for underground and surface annual refresher training were combined for analyses. A one-way ANOVA was performed on the twelve variables identified as research considerations with scores on the pretest and posttest serving as criterion variables. Although, many of the variables investigated were significant in either the pretest or the posttest analysis, only the results of the pretest can be analyzed with some confidence.

A summary of these analyses is given in Table 5.

TABLE 5

SUMMARY OF ANOVA
ANNUAL REFRESHER TRAINING

	Pretest	
	F	p-value
Previous Health and Safety Technology	9.36	.003
Received Inexperienced Training	13.75	.000
Received Task Training	10.99	.001
Trainer Uses Tests	18.46	.000
Age	1.27	.158
Level of Schooling	6.35	.000
Experienced New Hire Training	3.92	.049
Accident (Within Year)	2.68	.103
Type of Training	1.18	.320
Job Classification	1.93	.006
Years of Mining Experience	7.06	.854
Years at this Mine	1.21	.248

The miners had no motivation to perform well on either the pretest or the posttest measure. However, fewer instances of noncompliance were found in taking the pretest. Therefore, these results are reported.

Not surprisingly, any type of previous training was a significant variable for the pretest scores. This included previous health and safety training, inexperienced training, task training, and new hire training. Interestingly, years of mining experience was not significant ($p = .854$). The data also suggests further investigation for age ($p = .158$), and recent accidents ($p = .103$), since these indicate marginal significance.

DISCUSSIONS AND RECOMMENDATIONS

The one-way ANOVA analysis used was not wholly appropriate since the data violated the assumptions of independence and homogeneity of variance. Group size was not equivalent ranging from n = 9 to n = 44. The analysis was useful, however, in highlighting those areas requiring subsequent and more intensive research.

Primarily, it was discovered that measurement techniques frequently used in classic classroom investigations are not appropriate for evaluating mine training. The greatest barrier to test use as a measure of course effectiveness in an actual training situation is that of miner motivation. Innovative evaluation methods must be investigated to assure accurate conclusions in future research efforts. Unless the trainer is able to generate a high level of motivation within his or her class, the trainee has no concrete reason for attaining a higher level of achievement on a written test. This observation emphasizes how very trainer intensive mine training is.

In terms of the test scores alone, it appears that significant gains were evidenced. As shown in Table 6, the average test score for the new miner training was 50% correct for the pretest and 79% correct for the posttest. For the annual refresher training, the average pretest score was 59% correct, and the average posttest score was 71% correct.

TABLE 6

AVERAGE SCORES
BY TYPE OF TRAINING

Type of Training	Pretest (% correct)	Posttest
New Miner	50	79
Annual Refresher	59	71

The smaller gains for the annual refresher training were compromised in some cases by lack of time, compliance, and haphazard responding.

It should be pointed out that we are not advocating extensive use of written pretests and posttests. These were used here for the purposes of this study to serve as criterion variables.

Other areas that appeared to contribute to effective classroom training should also be addressed in more depth. Through examination of the test scores and through discussions on various observations in both the new miner and annual refresher training, it was evident that further efforts should be directed toward improving trainer skills. Workshops should be designed to strengthen trainer skills in such areas as encouraging trainee participation, efficient use of class time, measurement techniques for assessing trainee performance for use in formative and summative evaluations, effective instructional strategies (e.g., use of stories and examples, tailoring methods, etc.) and strategies for gaining organizational support for training efforts within the company.

CONCLUSIONS

A great deal of work still lies ahead in determining effective means for training the mining population. The results of this study do not give procedures that guarantee effective training. It does, however, define those areas that warrant additional investigation.

There exists a need in evaluating miner training programs to go beyond the classic evaluation techniques that incorporate the experimental paradigm. With its federally mandated training, the mining industry provides the industrial trainer and the educational researcher with fertile ground for developing and customizing better instructional strategies and evaluation methods.